U. S. DEPARTMENT OF AGRICULTURE

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TOMATOES AS A TRUCK CROP

THE tomato, a horticultural crop of American origin, now ranks third in importance among our truck crops. The demand for high-quality table or slicing tomatoes is increasing, and there is need for improvement in the quality of the tomatoes grown for the early market.

Thousands of carloads of early tomatoes are shipped to our leading markets during the winter, spring, and early summer from the Southern States, Mexico, Bermuda, the Bahama Islands, and the West Indies. Great quantities of tomatoes are grown as an intensive truck crop throughout the Northern States by special methods of forcing, pruning, staking, and other means of producing an early or superior product. The production of tomatoes under glass is also an important industry.

Suitable soil, good seed, and well-grown plants are the foundation for the production of early tomatoes of high quality, and a number of seed firms are now making a specialty of strains and varieties that are adapted to the work. Marked progress has also been made in the development of strains that are resistant to disease.

Outstanding cases of truck growers who have been especially successful with tomatoes are frequently found, and this bulletin is largely a summary of their methods and results.

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TOMATOES AS A TRUCK CROP

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CONTENTS

INTRODUCTION [1]

FRESH or table tomatoes are now to be had in the leading markets of the United States practically the entire year, the supply in the late fall, winter, and spring coming from the west coast of Mexico, Bermuda, the Bahama Islands, Cuba, the Southern States, and the great vegetable-forcing houses of the Northern and Eastern States. The summer and early fall supply comes from the thousands of truck gardens and farms scattered over a wide area, especially in the North Central and Northern States.

It would be difficult to estimate the acreage devoted exclusively to early tomatoes in the United States on account of the frequent overlapping of crops grown mainly for canning and manufacturing. The present need of the early and truck-crop tomato industry is not increased acreage but a general improvement in the methods of growing, grading, packing, and marketing the crop.

Fresh tomatoes are shipped in car lots from more than 20 States, but the bulk of the early table stock comes from 6 States. The season begins in Florida, and follows in California, Texas, Mississippi, Tennessee, and New Jersey in about the order named. Figures are not available to show the great quantities of fresh tomatoes sold locally and those produced in home gardens and used in the homes. The production of early fresh tomatoes in the Southern States is more or less localized, while the general market-garden and truck crop of the North Central and Northern States is very generally and widely distributed.

[1] The tomato industry of the United States is naturally divided into more or less distinct branches, according to the use made of the product: (1) The truck and general market-garden crop, including the early table tomatoes grown in the Southern States and those grown for the market throughout the country; (2) the production of tomatoes for canning and for manufacturing; and (3) the production of tomatoes under glass, this latter being simply a special phase of table-tomato production. This bulletin contains information relative to the growing of early, midseason, and late tomatoes for the general market. Farmers' Bulletin 1233 treats of the growing of tomatoes for canning and manufacturing. Farmers' Bulletin 1291 gives information upon the grading, packing, and shipping of early tomatoes. Farmers' Bulletin 1431 treats of the growing of tomatoes under glass. Early and truck-crop tomatoes are grown in areas varying from small patches to large acreages, the total for the United States, according to the figures compiled by the Bureau of Agricultural Economics for 1936 census, being about 182,980 acres, exclusive of those grown for the canneries.

In Florida the important early tomato sections are around Miami and from Boynton to Florida City, around Palmetto, near Lake Okeechobee, and in the central and north-central parts of the State. In Mississippi the early tomato industry is located mainly around Crystal Springs and Hazlehurst. In Texas early tomatoes are grown extensively around Alto, Jacksonville, Tyler, and other points in the eastern part of the State. Most of the shipments from California originate near Los Angeles. In Tennessee the towns of Humboldt, Gibson, and Milan hold first place in tomato shipments. Marietta, Ohio, and Anna and Cobden, Ill., are important early tomato producing points. New Jersey, with the town of Swedesboro as a leading shipping center, supplies the eastern markets with great quantities of midseason fresh tomatoes. In the New England States the market garden tomato industry centers around Boston, Providence, New Haven, Hartford, and other points. Rochester and Buffalo are important centers in New York; and Ashtabula, Cleveland, and Toledo in northern Ohio. In fact, midseason tomato production is highly developed around every important market of the North Central and Northern States except the extreme Northwest, where climatic conditions are not so favorable for tomatoes.

Exceptional results in the production of fancy table tomatoes are often obtained by members of boys' and girls' clubs and by truck gardeners, who follow the practice of growing 1,000 to 10,000 plants either in pots or in special beds and setting these on one-tenth of an acre to 1 acre of well-prepared land. By this system the plants are set closer than in regular field culture and are pruned to a single stem and tied to stakes or to a trellis. Cases are reported where more than $6,000 worth of tomatoes have been sold from an acre during a season by this method of culture. Results like this are extremely exceptional, however, and are obtained only under the very best conditions.

SOILS ADAPTED FOR GROWING TOMATOES

Tomatoes may be grown on a wide range of soil types, but a warm, well-drained, and fertile soil is essential for earliness, high quality, and grade. A large part of the southern early tomato crop is produced on sandy loam soils having a clay subsoil and capable of being worked very early in the spring. Land that is slightly rolling, or which has a gentle slope toward the south or southeast, or which is located where it has the protection of a thick piny woodland or a hill to the north is considered ideal from the standpoint of earliness. In New Jersey, Delaware, Maryland, and others of the Atlantic Coast States truck-crop tomatoes are grown for the most part on sandy loam soils, the selection of the land being made with early maturity of the crop prominently in mind. In the Northern and Mid-Western States tomatoes are planted on almost all types of soil, those of a loamy or sandy loam character being given preference.

Profitable tomato culture is largely dependent upon the soil on which the crop is grown being in the proper physical condition. Heavy soils and those that are poorly drained or which are plowed while too wet seldom yield a profit. Soils that are deficient in organic matter or that are in need of lime are not satisfactory for the production of tomatoes. Plant food can be added in the form

of fertilizers, but no amount of concentrated plant food will atone for a run-down and poor physical condition of the soil.

CROP ROTATION

Crop rotation is a matter of great importance in tomato growing, regardless of soil type or locality. Land on which manure was applied to a cultivated crop the previous season or which has grown a crop of clover or other soil-building crop is preferable. Tomatoes should not follow tomatoes, and the rotation should not include potatoes, peppers, or eggplant, as these are liable to transmit the diseases affecting the tomato. Certain weeds that are closely related to the tomato, such as ground cherry or husk tomato (Physalis) and horse nettle (*Solanum carolinense*), are known to be carriers of certain tomato diseases, and land infested with these weeds should not be planted to tomatoes. Nematodes, or gallworms, are particularly troublesome on many of the sandy soils of the South and many loam soils of the North, causing gall-like formations on the roots of the tomatoes, as shown in Figure 1. It is impracticable to recommend a definite crop rotation that will be adapted for all localities, but in general tomatoes should be grown in a rotation covering at least four years and including one cultivated crop in addition to the tomatoes and one or more root-knot resistant, soil-building crops. The important considerations from the standpoint of crop rotation are the avoidance of loss from disease and the securing of high yields and quality. In some localities this may be accomplished by a 4-year or 5-year rotation, but in others a much longer cycle or rotation may be required.

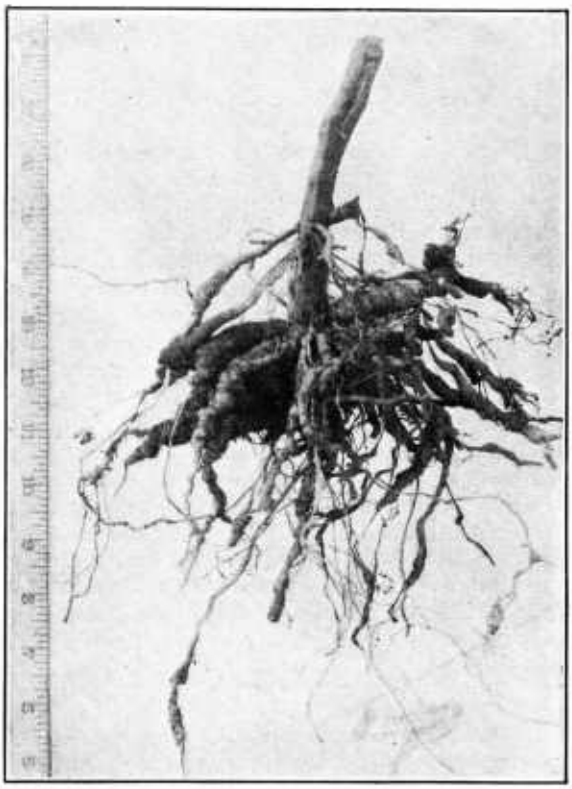

FIGURE 1.—Root of a tomato plant affected with root knot, caused by nematodes, or gallworms

In Florida the tomato fields are allowed to grow up in heavy grass during the summer, this being either cut for hay or plowed under as a soil-improvement crop. In Texas and Mississippi toma-

toes are followed the same season with sweetpotatoes, peanuts, velvetbeans, or cowpeas. In Indiana, where considerable acreages of tomatoes are pruned and tied to stakes, it is customary to pinch the heart out of the plants after about four clusters of fruit have been formed, and after the early fruit is marketed a hill of Kentucky Wonder beans is planted by each stake and the beans allowed to climb upon the stakes and the old tomato vines.

In the New England States the fruiting season for tomatoes usually extends until the vines are killed by frost, and there is little opportunity for intercropping or the planting of soil-building crops the same season that the tomatoes are grown. Under these conditions it becomes necessary to extend the rotation period to include provision for the growing of soil-improvement crops.

VARIETIES OF TOMATOES FOR THE MARKET

Eight or ten varieties of tomatoes are included in the list for early growing, but the bulk of the southern crop grown for shipment consists of Globe, Marglobe, Gulf State Market, Early Detroit, and Pritchard. Recently a new wilt-resistant variety known as Glovel has been developed for Florida and the Gulf coast region.

In the North Central and Eastern States the Bonny Best, John Baer, Earliana, Greater Baltimore, and Marglobe are leaders. In California the Stone is most generally grown. Gulf State Market and Early Detroit are grown extensively in eastern Texas, and these varieties produce fruit of medium size but very solid. Earliana is not grown to any extent in the extreme South, as its fruits are inclined to be rough, and the yield is not so good as that of some other varieties. In the northern section Bonny Best is one of the leading varieties for staking and pruning. Occasionally a grower is found who has a market for Ponderosa or some similar large variety. Bonny Best, John Baer, Greater Baltimore, Marglobe, and Pritchard are the varieties recommended for northern growing, although a few growers have excellent success with Earliana and Chalk Early Jewel.

SOURCES OF TOMATO SEED

Some seed firms in the United States are making a specialty of high-class tomato seed and are now supplying the greater part of the seed used by the growers of early tomatoes. In a limited number of cases growers are selecting and saving their own seed with marked success, but this is the exception and not the rule. Seed firms growing selected seed under personal supervision are in a position to supply the tomato growers of a given section with seed of a practically uniform strain, thus insuring reasonable uniformity of the product at shipping time.

In view of the fact that the quality, strain, and trueness to variety type of the tomato seed used by truck growers have such an important bearing upon the earliness, yield, and uniformity of the crop, no pains should be spared in obtaining the best, and the original cost should be of secondary consideration. The fact that certain growers are paying extremely high prices for specially grown and selected tomato seed, however, does not justify the seed dealer in

charging the grower more than high-grade seed of uniform strain is worth on the market. In view of the fact that only about 2 ounces of tomato seed are required to produce plants with which to set an acre, the grower can well afford to pay a fair price, provided he gets the quality he is paying for. In no case should miscellaneous or canning-factory seed be used, but only high-grade seed of known quality. Some growers follow the practice of purchasing their supply of seed a year in advance and testing a small quantity to see that it is true to variety and type. Where this is done special care should be taken to protect the seed from moisture while it is held in storage.

Marked progress has been made by the workers of the United States Department of Agriculture and others in the development of disease-resistant varieties and strains of tomatoes. The effort has been mainly to obtain varieties that are immune to fusarium wilt, a disease that is especially prevalent in the Southern States. Several varieties have been developed, but the one known as Marglobe is perhaps the most widely distributed and is showing excellent resistance on land where susceptible varieties proved a failure on account of the presence of wilt. In sections where the wilt does not occur the standard varieties of tomatoes have usually been planted, although Marglobe is of major importance. It is recommended, however, that growers having strains of tomatoes particularly adapted to their local needs give special attention to the further perfecting of these, and that where wilt is present one or more of the resistant sorts now available be planted.

METHODS OF STARTING EARLY TOMATO PLANTS

The profits derived from the growing of early tomatoes are dependent upon getting the product on the market while prices are high, and the first essential to earliness is the production of strong well-grown plants having the first bloom upon them by the time they are set in the open ground. In order to do this the seed should be sown indoors in a small hotbed or in a greenhouse.

In Florida, where the growing season is practically continuous throughout the year, the seed is often planted in the field where the plants are to remain, or the seed is sown in a bed where it can be watered and the plants transferred to the field when they attain suitable size. Eastern Texas growers sow the seed in small hotbeds which are usually flue heated and transplant to cloth-covered beds and later to the field. The system followed in Mississippi is similar to that of eastern Texas.

The growers of early outdoor tomatoes in the Northern States start the plants in greenhouses or hotbeds and handle them in pots or boxes prior to setting in the open. Some of the most successful northern growers complete the indoor growth of the plants in 6-inch clay pots such as are used by florists. By keeping the plants cool and well ventilated toward the last of their indoor period of growth they become very strong and stocky, having a wonderful root system. In view of the importance of producing good plants for the early-tomato crop, this phase of the work will be discussed under several headings and in considerable detail.

HOTBEDS AND COLDFRAMES [1a]

Hotbeds and coldframes should always be located in a sheltered place, either on a south slope, as shown in Figure 2, on the south side of a building, or where protected by a clump of low-growing pines. Where small native pines are abundant these can be used to create an artificial shelter by planting a temporary hedge of them on the north and west sides of the bed. In eastern Texas and in Mississippi coldframes to which the plants are transplanted are usually located in the center or alongside each acre on which the tomato crop is to be grown. In the Northern States the coldframe is generally located near buildings or on a southern slope where it will get the greatest benefit from the sunshine and be protected from the wind.

The eastern Texas and Mississippi growers as a rule employ a flue-heated hotbed for starting the seedling tomato plants. This

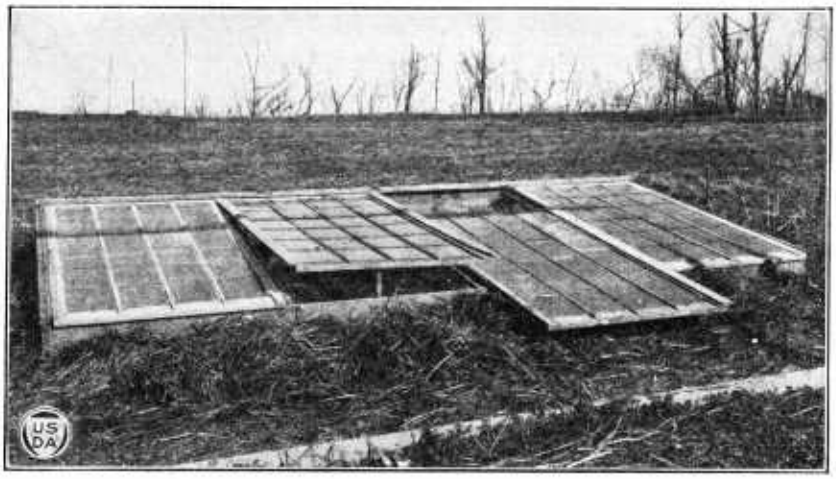

FIGURE 2.—A hotbed suitable for starting early tomato plants

type of bed is constructed by digging a pit about 3 feet deep, 6 feet in width, and 12 or 14 feet in length along the side of a south slope or small hill and as near the house as practicable. A flue is then built the length of the pit, using loose field stones or bricks for its construction. A chimney or metal smoke flue is provided at the opposite end from the furnace, and the pit is covered with a board floor and provided with 10-inch or 12-inch plank or concrete sides. The covering for these beds consists either of sash or of heavy muslin tacked to a roller and supported on crosspieces nailed to the top of the plank sides. Heat is provided by burning stumps, trash, or partly seasoned wood that will give a slow even heat. About 6 or 8 inches of good sifted loam is spread upon the floor of the bed and the seeds planted in rows crosswise of the bed, the rows being spaced about 4 inches apart. In a few instances the plant bed is located alongside the house and heated from the hot-water, steam, or hot-air heating system of the dwelling, but in this case the bed is usually made in the form of a lean-to or pit on the south side of the dwelling,

[1a] For more complete information on hotbeds and coldframes see Farmers' Bulletin 1743.

as shown in Figure 3, and is used for other purposes in addition to starting tomato plants.

Manure-heated hotbeds are constructed in the same manner as the flue-heated beds except that the pit for the manure is only about 12 inches in depth and without the raised floor required in the flue-heated beds. The heat is provided by tramping a layer of horse or mule manure in the bottom of the pit to a depth of 6 to 12 inches, according to location, time of winter, and the outside temperature that must be reckoned with. The manure should be reasonably fresh and free from burning or previous expenditure of its heat. Prior to putting it into the bed the manure should be stacked in a low flat pile and turned over once or twice in order to start uniform heating.

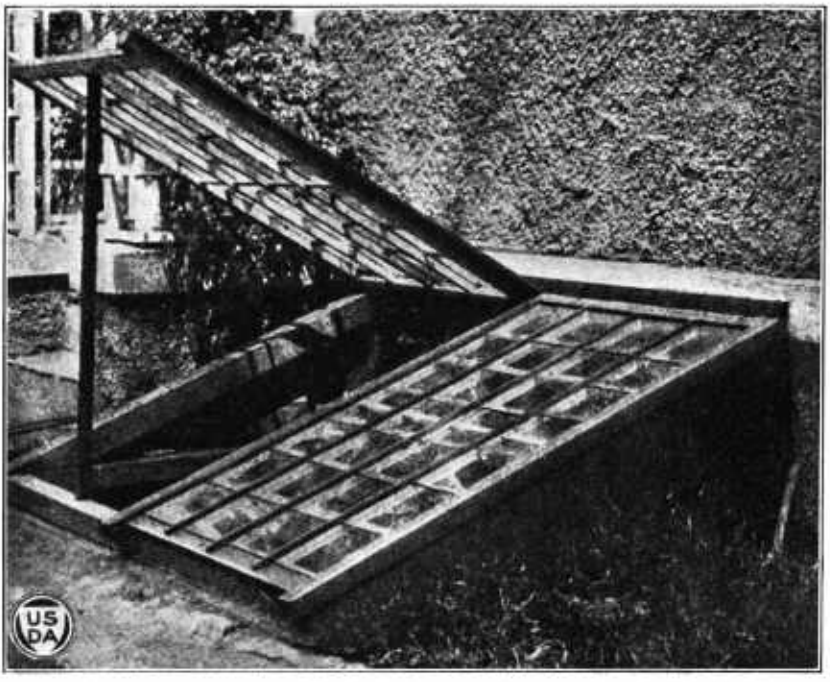

FIGURE 3.—Pit attached to a residence and heated by the home-heating plant

If the manure is very dry, a small quantity of water should be sprinkled over it while being turned. The manure should not be forked into the bed in large masses but should be shaken through the tines of a fork in thin even layers all over the bed. As each layer is spread it should be tramped moderately, and after the placing of the final layer the entire bed of manure should be well tramped. Following the placing of the manure in the bed, about 6 inches of good sifted-loam soil should be spread over the entire surface. A manure-heated bed should be made several days before the date for sowing the seed, in order that it may heat to its highest point and the temperature recede to 85° F. or lower before the seeds are sown.

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The coldframe in most general use by the growers of Texas and Mississippi is 10 by 60 feet in size, with a ridgepole through the center, sloping ends, strips or rafters to support the cover, and 8 to 10 inch boards for the sides. As a rule the bed is located right on the land where the crop is to be grown, one bed of the above specified size setting 5,400 plants 4 by 4 inches, or enough plants to set 1 acre. The covering for these beds consists of heavy unbleached muslin sewed together to form a large sheet. This is spread over the bed and fastened to the ridgepole by nailing a strip of wood over it. The edges of the sheet are clamped between two strips of wood running the full length of the bed and forming rollers upon which to roll the sheet to the ridge from either side. The ends are held down by loops of tape sewed to the sheet and fastened over nails driven into the ends of the bed. A good idea of a bed of this type can be

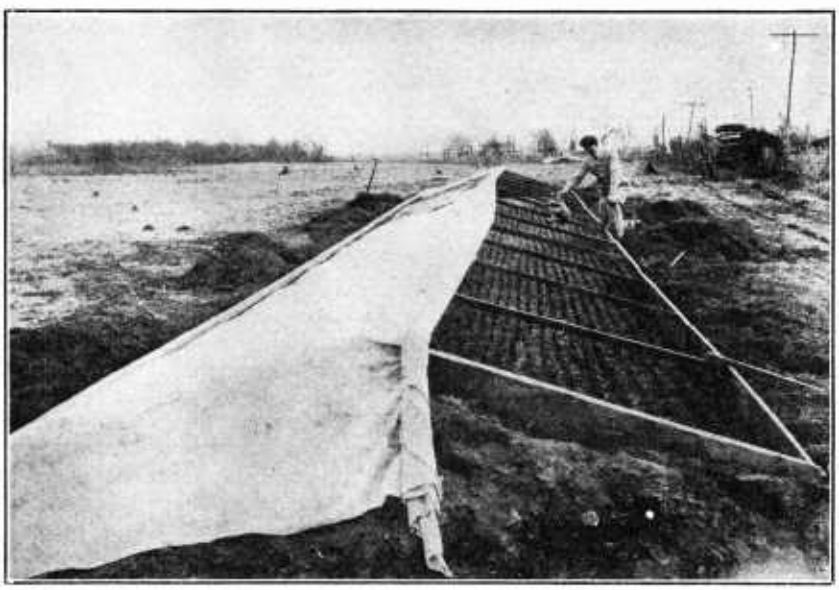

FIGURE 4.—Type of coldframe used by the tomato growers of Texas and Mississippi for growing early plants after starting the seedlings in the hotbed

gained from Figure 4. As an added precaution against a sudden drop in temperature a quantity of light prairie hay or pine straw is provided, and if necessary this is spread over the sheet to a depth of 2 or even 3 inches. In removing the straw covering a large broom is used. In some instances it has become necessary to hang lighted lanterns inside the frames during cold nights.

Many of the growers of early tomatoes in the section lying too far north for the use of the cloth-covered coldframes but not so far north as to require great protection for their beds have found the use of hotbed sash and straw mats sufficient. Usually the beds are well banked on the outside with fermenting manure to keep out the cold.

A number of growers of early tomatoes in New Jersey have provided permanent concrete beds which are heated by means of hard-

coal burning hot-water boilers and a system of pipes under and around the bed. The usual custom is to place the heater in a pit at one end of the bed or often in the basement of an outbuilding to which the bed is attached. These beds are often made 20 by 40 or 20 by 60 feet in size and are used mainly for starting sweetpotato plants, a small portion only being used for tomatoes. The covering for these beds is either heavy muslin, light canvas, or sash. The heater pipes are carried from the boiler through the center of the bed and return around the outside. In a few cases heater pipes are either buried in the soil or run through 3-inch tiles laid in the bottom of the bed and covered with a foot or more of soil. The first cost of a bed of this character is high, but if properly built it will last for a great many years and is very effective and economical in its operation. A bed of this type is shown in Figure 5.

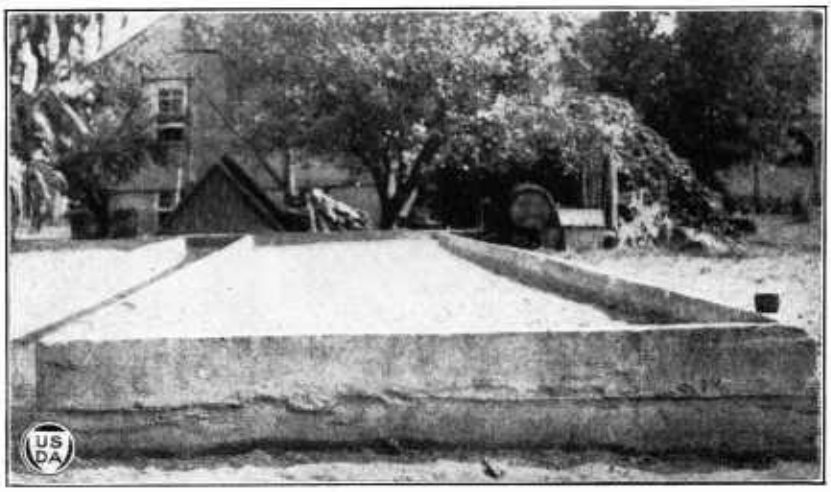

FIGURE 5.—Permanent concrete bed provided with hot-water heater used by a New Jersey grower for starting early plants. The heater is located in the basement of the building in the background

In the Northern States, where greater protection is necessary, the growing of plants requires the use of greenhouses or heated frames. A brick or concrete pit 18 to 24 inches in depth covered with ordinary hotbed sash and located along the south side of a greenhouse from which it can be heated is perhaps the ideal method of growing early tomato plants.

One of the most successful growers of early tomatoes in northern Massachusetts finishes his tomato plants in 6-inch pots in a low greenhouse formerly used for growing cucumbers. This house has both top and side ventilation, making it possible to grow stocky plants. A tomato plant of this type is shown in Figure 6. To produce 8,000 to 10,000 such plants will require a space 8 by 8 inches for each, or 4,000 square feet of bed space. By using 5-inch pots and crowding the plants a little 10,000 plants can be carried on 2,500 square feet of bed surface, but it should be borne in mind that in order to grow good plants plenty of space must be provided.

GROWING TOMATO PLANTS

Tomato seed sown in a hotbed in eastern Texas or in Mississippi from January 28 to February 15 will produce plants for setting in the field in six to eight weeks; usually in about 50 days. Some growers plant the seed earlier than this, but it is better to keep the plants growing rapidly from the start rather than have them too early and then become checked. The time of sowing seed, however, will vary with the locality and must be determined by the time that the plants can be set in the field. The seed should be sown in rows about 4 inches apart, 6 or 7 seeds to the inch, and covered half an inch deep. After the seeds have been covered the surface of the soil should be watered with a sprinkling can, being careful to distribute the water uniformly over the bed. This watering will settle the soil about the seeds and also supply the necessary moisture to sprout them. During bright days a bed that is covered with sash will heat very quickly, and it will be necessary to ventilate either by sliding the sash partly off the bed or by tilting the side opposite to the wind. In the case of a cloth covering, it should be rolled part way up or lifted on the side opposite the wind. Toward evening the bed should be closed, so as to retain the heat for the night. Watering should be done only when necessary, as excessive or careless watering will cause the plants to damp-off at the surface of the ground or make a soft growth. Watering should be done early in the day, so the plants will dry off before the bed is closed for the night. The seed bed should not be allowed to dry out, but great care must be exercised both as to the quantity of water and the time of applying it. The usual practice is to have a barrel or two of water at the plant bed and apply the water as needed, using an ordinary 10 or 12 quart sprinkling can.

FIGURE 6.—A good pot-grown tomato plant ready for setting in the field

Work should be started on the preparation of the coldframes immediately after sowing the seed in the hotbed. If these beds are to

be located in the field, the land should be first plowed, then the framework put in place. The next step is to scatter about 10 quarts of fertilizer over the surface of the 10 by 60 foot bed and work this into the upper 4 inches of soil with a spading fork. The bed should then be left to settle for several days, or until the plants in the hotbed are ready to transplant. A day or two before transplanting begins the muslin cover should be fastened on the bed and the surface of the soil raked to a smooth, fine texture. Two or three barrels of water should be hauled and placed at a convenient point alongside the bed; also about two loads of marsh or prairie hay or its equivalent in pine straw should be piled near the bed. Two boards 1 inch thick, 12 inches wide, and just a little less than 10 feet long, so that they will drop into the bed crosswise, will be required to work upon while setting the plants. A row of small pegs, 4 inches apart, nailed to the edge of one of these boards will serve as a marker and form the holes in which to set the plants. Some growers, however, prefer to have a separate marker consisting of a 1 by 3 inch lath to which the pegs are fastened, as better openings in the soil are made with this type of marker than with the board.

Tomato seedlings will be ready to transplant from the hotbed to the coldframe in 16 to 20 days after sowing the seed, depending upon the amount of sunshine and the care given the bed. The plants first have the two seed leaves with which they come through the ground. A day or two later the first true leaf begins to develop, and when the plants have their second true leaf in addition to the seed leaves they will be ready for transplanting. The hotbed should be ventilated freely, or the covering removed entirely on bright days, to harden the plants before transplanting. A calm cloudy day is preferable to a windy bright day for transferring the plants from the hotbed to the coldframe. Before starting to lift the plants they should be watered, so that the soil will adhere to their roots. The plants should be lifted carefully by running a trowel or a thin paddle under them and placed in shallow boxes for transferring to the coldframe.

Tomato plants should be set in the coldframe about an inch deeper than they stood in the soil of the hotbed. Special care should be taken to see that the soil is well firmed about their roots and that the tops stand straight and uniform. Water should be sprinkled over the plants as fast as the rows are set, the quantity applied depending upon the moisture content of the soil. If the soil of the coldframe is too dry it should be watered the day before transplanting, but due consideration should be given weather conditions, as showers are liable to occur frequently at that time of the year. Two men can easily transplant one coldframe in a day if everything is in readiness.

Following transplanting, the tomato plants should be kept well shaded with the cloth covering for a day or two until they recover. In case the sunshine is bright the cover should be raised along the edge, but the plants should not be subjected to strong wind. During cold or rainy weather the covers are kept battened down tight to the frames, and in case of freezing the straw covering is put on early in the afternoon. During bright weather the curtains are rolled up, usually on one side only at first, in order to protect the plants from the wind. The object of the grower is to keep the plants growing strong and stocky right from the first and to avoid extremes of

temperature or moisture conditions. As the time for setting in the field approaches, the covering is kept off most of the time to harden the plants to outdoor conditions.

In the North Central States the tomato seed is sown in flats in the greenhouse from February 20 to March 10. The plants are first pricked off into other flats and later into pots, or they are handled in 2-inch pots at first and then shifted to larger pots as growth and root development proceed. Tomato plants grown in pots are liable to become root bound, and it is often necessary to shift to pots as large as the 6-inch size in order to prevent serious checking of the growth. One-quart berry boxes are sometimes used as containers for early-tomato plants; also paper pots, paper bands, and wood bands. Pieces of inverted sod are sometimes used as a base for growing the plants, these being transferred to the field with the plants. Clay pots give the best results, but these are not normally practicable for use on a larger scale than for planting 2 or 3 acres.

FIGURE 7.—A good transplanted tomato plant ready for setting in the field

Watering pot-grown plants requires skill and frequent attention, in order that the soil may neither dry out nor become water-logged. A good plan in potting the plants is to place a few pieces of a broken pot or some small stones over the drainage hole in the bottom of each pot. This will insure good drainage and aeration of the root system. Paper pots require even greater care than clay pots to avoid overwatering.

The proper spacing of the potted plants on the greenhouse bench or in the coldframe is of vital importance in the production of strong stocky plants. Where the plants are transferred directly into the soil of the coldframe they should be given at least 4 inches in each direction and then set in the field before they crowd each other. A plant grown in a coldframe and in proper condition for planting in the field is shown in Figure 7.

PREPARATION OF LAND

Land on which tomatoes are to be grown is usually plowed three or four weeks before time to plant, in order to give opportunity for thorough preparation and for the application of manure and fertilizers. In a few cases the land is plowed in the fall and left exposed over winter. Thorough and reasonably deep plowing is essential, and where any grass is to be turned under a chain or colter should be used in order to cover it completely. The greater part of the harrowing and pulverizing work should be done shortly before planting; however, the preparation of the soil depends considerably upon the kind of fertilizers or manure used and also on the locality and the method of growing the crop. No special tools other than the regular plows, harrows, and cultivators of the ordinary farm are required for growing a crop of tomatoes. One of the most important tools, in addition to the plow, is a disk harrow, with which to cut and pulverize the soil. Some of the best tomato growers follow the practice of disking their soil four to six times previous to planting.

MANURES AND FERTILIZERS

Practices governing the use of manures and commercial fertilizers for tomatoes vary with the locality and the soil. Many growers prefer to apply manure to the crop preceding tomatoes rather than to the tomato crop itself. The growing period of the tomato is comparatively short; therefore, it is necessary that its plant-food supply be in a quickly available form, and this is not the case with fresh manure. Moderate quantities of well-rotted stable manure may be applied in the rows or worked into the soil for the early tomato crop, but should be supplemented with readily available plant food in the form of fertilizers. The application of large quantities of stable manure is liable to produce excessive vine growth at the expense of the setting of early fruit.

Coarse or fresh manure as a rule should not be worked into the soil in preparing for planting tomatoes, but if used it should be applied six months or a year in advance, preferably in connection with a crop of corn or some heavy-feeding crop. By this method the manure will become thoroughly decomposed and mixed with the soil before the tomatoes are planted. Compost, or rotted manure, may be applied to advantage on most soils at the rate of 4 to 6 tons to the acre in the furrows or 8 to 10 tons if broadcast. Where the manure is applied in furrows under the rows it should be thoroughly mixed with the soil by means of a single-shovel plow or a narrow cultivator. A double furrow is then thrown over the manure, making a sort of bed, which is leveled with a plank drag just before setting the plants. Growers of staked and pruned tomatoes sometimes apply a mulch of about 2 inches of fine strawy manure about the plants. This holds moisture and keeps down weeds, but retards the ripening of the fruit and often reduces the yield.

Practices involving the use of stable manure for growing tomatoes in the southern Florida district, especially around Miami, are decidedly different from those described above. In that section the land is extremely wet during a portion of the year, and it is often

a problem to get it dry enough for early planting. In order to overcome this difficulty a small quantity of manure is placed under each plant. This manure provides a dry footing for the plant, improves the drainage of the soil immediately under and around the plant, and at the same time provides food for the early growth of the plant.

Commercial fertilizers play an important part in the growing of the southern early-tomato crop, from the fact that manure is scarce and fertilizers give the plants a supply of quickly available plant food. The quantity and composition of the fertilizers, however, vary under different conditions. A formula in common use contains 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 to 6 per cent potash. Some growers use a formula of 2–8–2, such as is used for cotton and corn, then top-dress with 150 to 250 pounds of nitrate of soda to give the plants a rapid growth. In Florida a 5–5–5 fertilizer is sometimes used, in some cases a 4–8–6 formula being employed. The quantity of commercial fertilizer applied by the Florida growers varies from 800 to 2,000 pounds per acre, the rule being 1,200 or 1,400 pounds to the acre.

With the present scarcity of manure, the market gardeners of the Northern and Eastern States are coming to depend more and more upon commercial fertilizers. The quantity applied and its composition vary with the locality, but most of the tomato growers of the northeastern section are applying 800 to 1,400 pounds of a fertilizer having an analysis of 3 to 4 per cent nitrogen, 8 per cent phosphoric acid, and 6 per cent potash.

Commercial fertilizers are in some cases sown broadcast over the entire surface, but as a rule from one-third to one-half the total quantity is sown in the rows and the remainder broadcast. Where all the fertilizer is applied in the rows under the plants special care must be taken to mix it thoroughly with the soil to avoid injury to the plants. On land on which 8 to 10 tons of rotted manure has been broadcast or 4 to 6 tons placed under the rows it is customary to mark off the rows with a 3-row or 4-row marker, then distribute the fertilizer in a strip about a foot in width along the row, using a 1-horse fertilizer distributor with a fan-shaped device underneath to spread it. The fertilizer is then mixed with the soil by means of a cultivator.

In the southern Florida tomato district commercial fertilizers are applied throughout the growing season. Where only one side of the row is cultivated, as is often the practice, the fertilizer is applied in small furrows. First, about a week or 10 days after the plants are set a handful of fertilizer is placed on one side of the plant and generally left uncovered. Ten days or two weeks later more fertilizer is applied between the plants in the original planting furrow. A shallow furrow is then turned over this fertilizer. This forms a support for the plants. The third application is placed in the furrow made when the second application is covered. As many as five applications are made in this manner, the fertilizer being applied just beyond the feeding roots with a view to keeping the plants constantly supplied with plant food.

Where nitrate of soda is applied as a top-dressing, not more than 150 pounds should be used to the acre at one time, and not more than two applications should be made. The first application should be made about 10 or 15 days after the plants are set in the field and the second one, if made at all, about the time that the plants have set their fourth cluster of fruit. The nitrate of soda should not come in contact with the plants, nor should it be scattered too closely about their roots but uniformly distributed over a strip of ground about a foot wide on either side of the plants and cultivated into the soil.

PLANTING IN THE FIELD

Tomato plants should not be set in the open ground until danger of frost is over. Many growers make the mistake of setting their plants a little too early, and as a result they are injured by cold and checked in their growth. While it is true that well-grown tomato plants will often go through a temperature of 1 or even 2 degrees below the freezing point, they are certain to be injured by such exposure, and it is best to wait until the weather and soil are reasonably warm before setting out the plants.

In eastern Texas planting in the field is usually done about the first or second week in April. Occasionally the season is so far advanced that the plants can be put out the last week in March, but April 10 is considered the frost-free date for that section. In Mississippi the season is usually 10 days later. In northern sections the time for outdoor planting varies with the location, but for the most part ranges from May 1 to 15, May 12 being considered the ruling frost-free date for the region in which these early tomatoes are grown. As 3 to 5 acres constitute about the average area planted by an individual grower in Texas or Mississippi, it is possible to handle the entire setting in the field within a week's time; in fact, it is desirable to have the setting all done within a short period, in order that the fruit may mature at the same time. In Florida, where acreages are much larger, planting begins in the late autumn for winter fruiting, but as a rule the big planting is made in January. The product of this goes upon the market during the spring months, ahead of the Texas and Mississippi crops.

Too much stress can not be placed upon the importance of having the soil well prepared before starting to plant. Under the term "preparation" are included plowing, harrowing, the application of manure and fertilizers, as previously described, and finally the opening of the furrows or the holes in which the plants are to be set. Where the manure and fertilizer have been placed directly in the rows it is customary in disking or harrowing to leave 3 or 4 feet of the original mark at the ends of the field as a guide for relocating the rows at planting time. A single-shovel plow or a very small turning plow is generally employed for opening the rows ahead of the planting. Another method is to mark the field in both directions with a 3-row or 4-row marker and then set the plants in the intersections with planting trowels. In a few cases the plants are being set with transplanting machines the same as are used for tobacco and sweetpotatoes.

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PLANTING DISTANCES

Planting distances vary with the locality and the method of cultivation. The usual planting distances in the Texas and Mississippi districts are 3½ feet between the rows, with the plants 24 to 30 inches in the rows. At 30 inches in the row, approximately 5,000 plants will be required to set an acre. In those parts of Florida where the plants are not pruned or tied to stakes, the planting distances are 4 by 4 feet, although some growers plant 3 by 4, 4 by 5, and various other distances.

In the Miami district the tomato plants are frequently set 2 to 3 feet apart in rows that are 6 feet apart. Another method is to have a 6-foot space between two rows, then a 2- or 3-foot space, the narrow row being allowed to grow to weeds, which partially support the plants of the two rows. While this method may prove reasonably satisfactory under conditions in the Miami district, it can hardly be considered a good cultural practice.

About 3,000 plants to the acre are required for planting according to Florida methods, the land being marked in both directions and cultivation conducted both ways until the plants begin to cover the ground. In New Jersey the plants are set 3 by 4 or 4 by 4 feet apart. Where tomatoes are grown by the most intensive pruning and staking methods, as for example in the New England States, the plants are set in double rows 18 inches apart each way with a 3½-foot space between that and the next double row. By this method 8,000 to 10,000 plants are set on an acre.

SETTING THE PLANTS

The plant bed should be thoroughly watered a few hours before the plants are lifted. Where a hose is not available it is a good plan to have two or three barrels of water alongside the bed, and while the plants are being lifted the soil should be kept reasonably wet so that it will adhere to their roots. In Texas and Mississippi, where the plants are grown 4 by 4 inches apart in the coldframe, a large knife or trowel is used to cut between the plants in both directions. A square-pointed or planting trowel is used for lifting the plants, and they are taken up with a block of earth about 4 by 4 by 5 inches in size adhering to their roots, as shown in Figure 7. As the plants are lifted from the bed they are placed upon small board platforms about 30 by 30 inches in size having handles extending at both ends so that two men can carry them. These carriers hold about 40 plants each and are carried or hauled to the place where the plants are to be set. In the case of the field coldframes used in the Southwest, the sides and framework of the bed are removed before beginning to lift the plants, as shown in Figure 8. When the area has all been set except that occupied by the coldframe, this space is replowed, the rows extended through it, and the plants set so that they become a part of the field, the framework and coverings of the bed being hauled to the barn and stored until the following year.

Everything should be in readiness for planting and the crew organized the day before the plants are to be set in the field. In the tomato fields of eastern Texas it has been found economical to have a crew of seven or eight persons to do this work. The equipment for planting should consist of a horse and small plow to open the

furrows, a claw hammer and pinch bar for removing the coldframe, a sprinkling can and two or three barrels filled with water, three or four planting trowels, five or six platforms or shallow trays for carrying the plants, two hoes for filling the soil about the plants, and a cultivator with which to cultivate the soil between the rows after the plants have been set. Wheelbarrows are sometimes used for carrying the plants from the bed to where they are to be set, but have the disadvantage that in wheeling them over the plowed ground the shaking loosens the soil from the roots of the plants. The horse or mule used for opening the furrows, if a quiet one, may be left standing at the end of a row when not needed. One man opens the furrows as required and waters the plant bed; one or two men lift the plants from the plant bed and place them on the carriers, as shown in Figure 8. Two men are required to carry the plants from the bed to the field where one or two persons take them from the trays and set them in the ground, placing a little soil around each plant, as shown in Figure 9. The plants should be set about 2 inches

FIGURE 8.—Removing tomato plants from a coldframe for setting in the field

deeper in the field than they were in the plant bed. One or two men follow the plant setters with hoes and draw the dirt about the plants. Immediately upon the completion of the setting the field is cultivated and the soil worked well around the plants.

In case the plant bed is located at a distance from the field, low flat-top wagons are used for hauling the plants to the field, and as they are lifted from the bed the plants are placed in shallow boxes or on board forms about 24 by 30 inches in size, these being constructed of light material so as to be easily handled. These boxes or forms are placed on the wagon, which is driven through the field, and the plants taken from the wagon as they are set. By this system three or four hands can make fair progress setting the plants. If the land is very dry and it is necessary to water the plants as they are set an additional team and two laborers will be required.

In setting pot-grown plants the most rapid progress can be made by removing them from the pots at the plant bed, this being done by inverting the pot and jarring its edge on the side of the bed or something reasonably solid. The plants are then packed in trays

and hauled to the field. This method works very well where the plants have formed a matted-root system, but when the plants have not formed sufficient roots to hold the ball of earth together it will be advisable to transport the plants to the field in the pots, removing them as the plants are set. Plants grown in berry boxes are taken to the field in them, and when ready to set a knife is used and the boxes are cut away from the roots of the plants.

CULTIVATION

Tomatoes require frequent shallow cultivation, especially during the first four weeks of their growth in the field. The surface soil should be loosened as soon as it is dry enough after every rain. Hand hoeing between the plants in the rows is necessary after practically every cultivation, and all weeds should be kept out, as they not only rob the soil of plant food and moisture, but certain weeds

FIGURE 9.—Setting coldframe-grown tomato plants in the field

are carriers of diseases that attack the tomato. The tools required for the cultivation of tomatoes consist mainly of the types used in general farm and garden cultivation. Riding cultivators, such as are adapted for cultivating corn, are often used in the fields prior to the time that the tomato plants begin to spread over the ground. Where the plants are check planted cultivation can be maintained in two directions, thus almost entirely eliminating hand hoeing. In eastern Texas and in Mississippi 1-horse cultivators and sweeps are employed for the most part. An A-shaped cultivator having about 14 small teeth or a standard 5-shovel cultivator with two or three sizes of shovels will answer every requirement. Care must be taken to avoid deep cultivation near the base of tomato plants trained to stakes or other forms of support, as the feeding roots run close to the surface and there is not the protection and shading of the vines that are afforded where they spread naturally upon the ground. As already mentioned, a number of the northern growers of early tomatoes place a mulch consisting of about 2 inches of fine straw-

bedding manure along the rows. This mulch not only retains moisture but protects the shallow root system of the plants from the heat of the sun.

Cultivation of the tomato crop is discontinued by the growers in eastern Texas and in Mississippi about the time they begin to pick fruit. In case of a heavy rain during the picking season, which extends over a period of four or five weeks at most, a cultivator is sometimes run through the middles of the rows to loosen the surface and hold the moisture. New Jersey growers keep up cultivation until the vines begin to cover the ground, making further cultivation without injury impossible. Where irrigation is practiced by the growers of fancy tomatoes at the North, the soil is cultivated within a few days after each watering. Where tomatoes are pruned and tied to stakes in the home garden or club garden a wheel hoe is ideal for cultivation. The main point of cultivating tomatoes is to keep the surface soil loose and mellow and the ground entirely free from weeds.

IRRIGATION

Irrigation of early tomatoes is not practiced to any great extent in the Southern and Eastern States. Market gardeners of the North Central and Northeastern States, however, frequently plant an acre or two of tomatoes under overhead irrigation. The moisture requirements of the tomato are such that artificial watering is seldom necessary in humid regions during seasons of normal rainfall. During excessively dry seasons, however, the gardener who has irrigation facilities and applies a moderate quantity of water will be in the market late in the summer when tomatoes are bringing a good price. Knowing when and how much water to apply to the tomato crop is the determining factor in the matter of irrigation, as an excess of moisture often does more harm than good.

In arid or semiarid districts the usual method of applying water to other crops may be used for tomatoes. Care must be taken, however, to avoid overwatering, causing the shedding of the blossoms. Subirrigation by means of lines of tiles laid about 18 inches below the surface has been found ideal for tomatoes, as this method permits the application of water to the roots while the surface soil remains dry. Where tomatoes are watered on the surface of the ground it is essential that proper cultivation and the loosening of the soil should follow.

STAKING AND PRUNING

Growers of early tomatoes in Texas, Mississippi, and a number of other sections in the Southern States follow the practice of pruning the plants to a single stem and tying them to stakes. The growers of Florida and southern Georgia, where the acreages are much larger, still allow the plants to grow naturally upon the ground, however, though some are trying the staking and pruning method on a small scale. The growers of the Northeastern States frequently prune and tie an acre or two, but most of the tomatoes grown for the markets of this section are left upon the ground. In a few northern sections tomato growers follow a practice known as "leaf pruning," but grow the plants in the usual manner upon the ground.

The stakes used by the southern tomato growers are either split from pine logs, cut from sawmill edging, or consist of small saplings cut in the woods. They are usually 3½ to 4½ feet long and sharpened at one end so they may be easily driven into the ground. The stakes should be gotten out during the early winter and hauled to the field where the tomatoes are to be set. It is customary to choose a straight-grained pine tree, cut it into sections of the desired length, and then split it into slabs or bolts that are easily handled. A double-bladed ax is then stuck firmly into the stump and the stakes are split by striking the slabs upon the exposed blade of the ax. In this way the stakes are gotten out very rapidly.

Immediately after the plants are set a stake is driven beside each, the stakes being kept in line in the row and about 3 inches from the

FIGURE 10.—Tomato plants being grown by the pruning and staking method

base of the plant, as shown in Figure 10. Wooden mallets are generally used for driving the stakes, to avoid splitting them. The tying of the tomato plants to the stakes should begin immediately and be repeated every week or 10 days until about four tyings are made. Soft jute string, known in the tomato regions as "tomato twine," is used for tying. This string comes in large twisted hanks and can be cut off in short sections of about 9 or 10 inches as required. Raffia is also used extensively for tying tomatoes, especially by the northern growers. In tying, the string is passed around the stake and crossed between the stake and the stem of the plant, as shown in Figure 11. The roughness of the stake is generally sufficient to prevent the soft jute string from slipping down, and the stems should be drawn up close to the stakes. It is a good plan to form the tie just below a leaf, but this is not essential.

Early-tomato growers of the northern sections employ various methods of supporting the plants. Some use stakes 5 to 6 feet in length driven into the ground, others employ light bamboo stakes and tie them to wires at the top, as shown in Figure 12, while other growers use a regular trellis of posts and wires, as shown in Figure 13. The growers around Boston as a rule prune to two stems and tie to heavy strings which are supported by overhead wires. Many of the growers of the Central States use a combination of posts, wires, and lath stakes to support their tomatoes.

Pruning tomatoes, as commonly practiced, consists of cutting or pinching out all side branches as they appear about the base of the plant or in the axils of the leaves. Careful observation will show that the side shoots appear in the axil, or pocket formed by the leaf where it is attached to the main stem, while the fruit clusters are on the opposite side from the leaf and often a little above or below the point where the leaf is attached, as shown in Figure 14. The side shoots should be removed at least once a week during the active growing period, in order to throw all the vigor of the plant into the formation of fruit. In Texas and Mississippi the growing tip of the plant is pinched out after four or five good clusters of fruit have been formed. This practice of pinching out the growing tip of the plants is also followed in some of the North Central States where it is desired to market only the early crop.

FIGURE 11.—A tomato plant pruned to a single stem tied to a stake

Growers of early tomatoes around Buffalo, N. Y., New Haven, Conn., and elsewhere in the Northeastern States follow a practice known as "leaf pruning" to stimulate the early formation of the branches and the setting of a large number of fruit clusters. This is contrary to the single-stem method and consists of pruning away all the leaf except the inner two lobes or segments while the plants are from 6 to 8 inches in height. After the branches have started no further leaf pruning is practiced, and the plants are allowed to grow upon the ground in the usual manner. This system, it is claimed, causes the tomatoes to ripen 5 to 10 days earlier and at the same time gives a heavy yield of early fruit. In view of the

fact that no definite experiments have been reported, it is impossible to state the advantage, if any, to be gained by this method, though it is practiced by a considerable number of growers of early tomatoes.

INSECTS AND DISEASES

The tomato is subject to the attacks of a number of insects and diseases which require prompt attention on the part of the grower.

INSECT PESTS[2]

There are several important insect pests of the tomato plant, the most common of which are the cutworms, hornworms, potato flea beetles, and fruitworms.

FIGURE 12.—Tomatoes trained to light bamboo stakes which are supported by wires at the top

CUTWORMS

The cutworms are particularly destructive in the seed bed and shortly after transplanting in the field. These pests can be readily controlled by the use of poisoned bait, the bait being prepared as follows:

Dry bran	25 pounds.
White arsenic or Paris green	1 pound.
Sirup or molasses	2 quarts.
Water	15 to 20 quarts.

(1) Thoroughly mix the poison with the bran. This is important. Each particle of bran must carry a little poison to get a good kill. When making small quantities, the bait can be mixed in a bucket with a paddle, adding the poison slowly and stirring the bran at the same time. A still more effective way is to mix the poison and bran with the hands; but since soluble arsenic is absorbed to a slight extent through the skin, there may be some objection to

[2] Prepared by W. H. White, Division of Truck-Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine.

this method. If the hands have any cuts, scratches, or other wounds, do not put them into the bait. When making large quantities the poison can be mixed with the bran on some flat, smooth surface, using a shovel and rake in much the same way as is done in mixing concrete.

(2) Mix the sirup with the water.

(3) Add the water and sirup solution to the mixture of bran and poison, stirring slowly all the time. Large quantities of water added at one time will wash the poison from the bran and produce an uneven mixture.

Caution.—Add only enough liquid to make a crumbly mass. It is a good plan to set aside a little of the mixture of dry bran and arsenic so that if too much water has been used this dry reserve can be added to bring the mixture up to the proper consistency. Large quantities can be made up in galvanized iron or wooden washtubs and small quantities in buckets or similar containers.

The poisoned bait should be scattered along the rows in the seed bed late in the evening. It may require two or three applications to control the pest, especially if a rather heavy infestation of the

FIGURE 13.—Tomato plants trained on wire trellises

cutworms is present. Since many forms of cutworms overwinter in the ground, it is a good plan to broadcast the poisoned bait over the cultivated area a few days before the crop is transplanted to the field. This will serve to kill many of the worms before the crop is set out. If the attack of the worms takes place after transplanting, then the poisoned bait should be scattered near the base of the plants.

TOMATO HORNWORMS

Tomato hornworms (fig. 15) are large green worms which, when full grown, are about 4 inches in length. These worms are also known as tobacco hornworms, as they attack the tobacco crop also. The tomato hornworms are held under control to a large extent in many sections by parasites. However, sometimes they become very destructive and may in a short time destroy the plants over a wide area.

These pests in the young stages can be controlled to some extent by the use of calcium arsenate applied in the form of a spray or

dust. It is difficult to protect the tomato crop when the hornworms are nearly mature, as they feed very greedily and may eat up a large

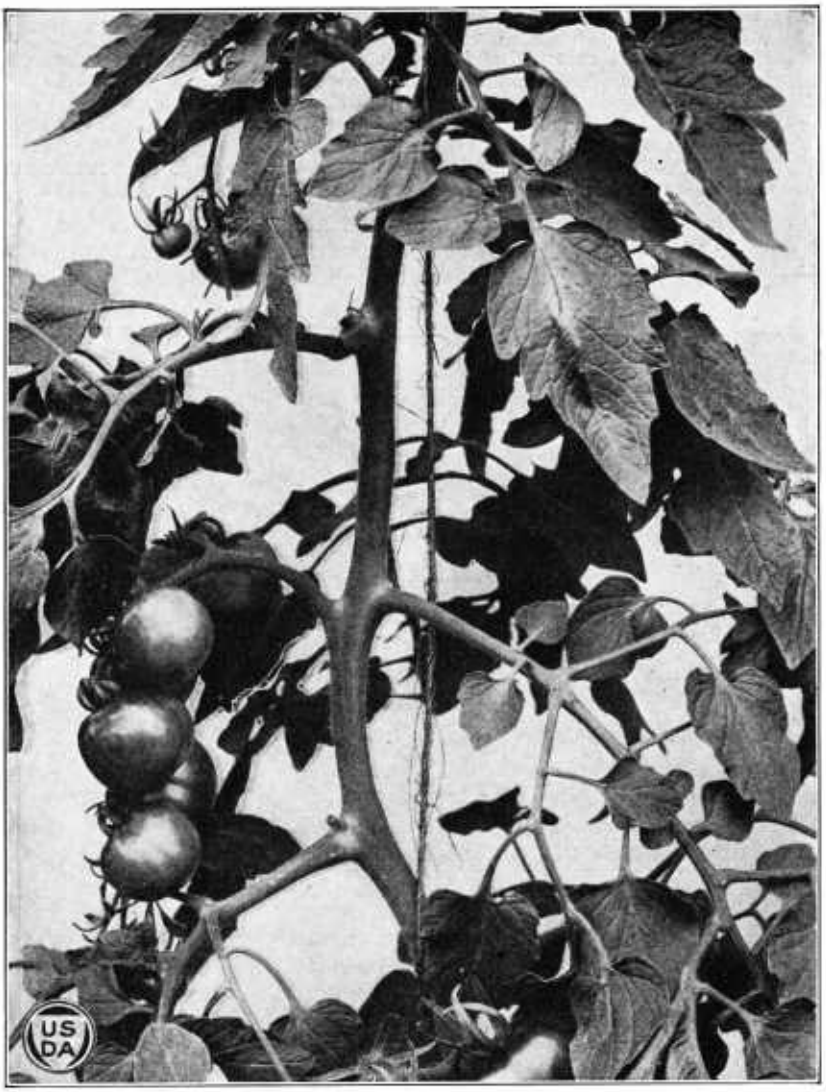

FIGURE 14.—Section of a pruned tomato plant, showing the location of leaves and fruit clusters on the main stem

quantity of the tomato foliage before succumbing to a poisonous dose of the arsenical. Hand picking is of value, particularly on small areas. In color the worms are very similar to the leaves of the plant, and it takes trained eyes to locate them.

THE POTATO FLEA BEETLE

The potato flea beetle is particularly destructive in seed beds and also in the field shortly after the plants have been set out. Keeping

the plants well covered with bordeaux mixture will protect them to a large extent. The bordeaux mixture should be so applied that it will reach all parts of the plant. If this is not done the flea beetles will seek untreated parts of the foliage or stem upon which to feed. Dusting every few days with a mixture of derris or cube containing 0.75 to 1 per cent rotenone will also protect the plants. For plant-bed treatment these dusts are very effective.

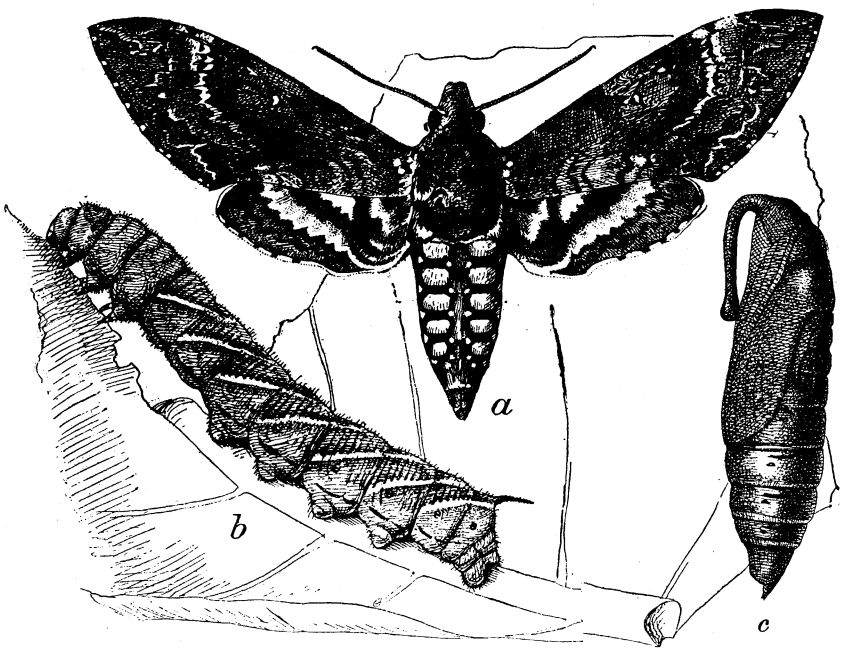

FIGURE 15.—One of the tomato hornworms (*Phlegethontius sexta*): *a*, Adult moth; *b*, larva; *c*, pupa. (Howard)

THE TOMATO FRUIT WORM

The tomato fruit worm (figs. 16 and 17) is the same insect as the cotton bollworm and the corn earworm. This insect frequently causes severe damage to tomatoes in the areas where early crops are produced and to the canning crop in the North and in California. The worms eat holes in the fruits and thus destroy their market value. Losses from worm damage to the fruits may be reduced by dusting with calcium arsenate. The first treatment should be made at about the time the earliest flower buds develop. In applying the material, efforts should be made to see that the whole plant is covered with the poison. Observations have shown that the moth from which the fruit worm develops lays its eggs on the outside edges of the plant. Covering the whole plant with the poison has the advantage of killing many of the worms before they reach the fruit. Treatments should be made at weekly or 10-day intervals. The quantity of material required per acre will depend upon the size of the plants, but effective coverage can be obtained with a minimum of 10 pounds of the calcium arsenate per application for the smaller plants and 30 pounds for the mature plants.

Caution.—Fruits taken from plants that have been treated with an arsenical should be washed or otherwise treated before they are marketed or consumed, in order that any traces of arsenical residues which might prove injurious to the consumer may be removed. For information relative to spray-residue removal write to the United States Department of Agriculture, Washington, D. C.

DISEASES[3]

The control of tomato diseases in the field is most effectively accomplished by measures designed to prevent infection of the plants rather than by attempts to check the progress of the disease after it has appeared. Since many of the more serious diseases may live over on the seed or in seed-bed soils, the use of chemical seed or soil treatments is often effective in securing disease-free plants.

DAMPING-OFF

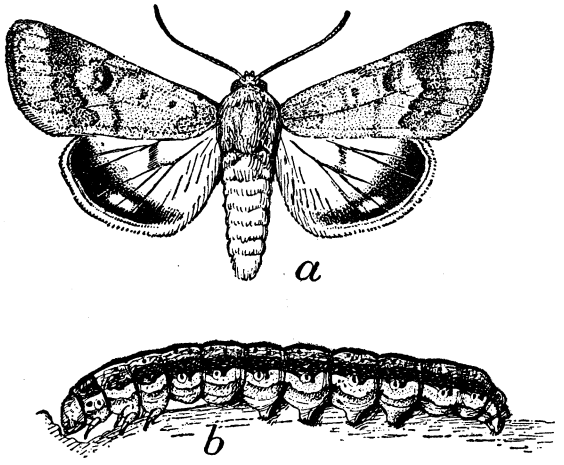

FIGURE 16.—The tomato fruit worm, bollworm, or corn earworm (*Chloridea obsoleta*); *a*, Moth, or adult; *b*, larva. About natural size. (Howard)

Damping-off of tomato seedlings is caused by various fungi that are often found in the soil. They can be effectively controlled by dusting the seed with red oxide of copper. The copper dust is used at the rate of 1 ounce of dust to 10 ounces of seed. The seed and dust are shaken together in a tight container, and after the seed is coated with the dust the excess dust is screened off. Seed may also be dipped for 5 minutes in a 1 to 1,200 suspension of New Improved 5 percent Ceresan and dried without rinsing. This treatment has proved effective in control of damping-off and is also of value in controlling certain seed-borne diseases. Seed treated with Ceresan should not be stored in airtight containers, as the seed may be injured if stored in this way.

The use of a 6-per-cent formaldehyde dust in the soil is also efficient in the control of damping-off fungi. In treating soil in bulk, the dust is used at the rate of 8 ounces to a bushel of soil, and the dust and soil are thoroughly mixed before using. In hotbeds or benches, the dust is applied at the rate of 1½ ounces per square foot and is worked in thoroughly to a depth of 3 inches. After the soil and dust are mixed, the seed should be planted at once and the soil watered thoroughly immediately after planting. Insufficient watering at this

[3] Prepared by S. P. Doolittle and A. C. Foster, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

time may result in injury to the seed. Six-per-cent formaldehyde dust may be purchased or can be prepared by adding 1 pint of commercial formalin (40 per cent formaldehyde) to 5¾ pounds of a carrier composed of ground charcoal, sifted leafmold, ground peat, or screened muck. The formaldehyde can be mixed with the carrier by stirring or by rolling in a tight drum containing a few stones. Dust made in this way must be kept in airtight containers and should not be stored for long periods, since it deteriorates rather rapidly.

LEAF SPOT

Leaf spot is a disease in which the leaves, beginning at the base of the plants, become covered with small, dark-brown spots and eventually wither and die. The fungus causing leaf spot lives over winter on the remains of the previous crop. Diseased vines should be plowed under deeply in the fall, and crop rotation is also important. In seasons when conditions are favorable to leaf spot, it may prove profitable to spray with bordeaux mixture, but as bordeaux sprays have been found to cause some reduction in yield, they are likely to be of value only when injury from the disease is severe. Spraying should be begun before the disease gains headway, but recent results have indicated that it may be possible to delay spraying until leaf spot begins to appear in midsummer and still secure adequate control. Such a practice will considerably reduce the injury from the bordeaux spray, as the plants are most susceptible to such injury in the younger stages of growth. Spraying should be repeated at intervals of 1 week to 10 days, taking care to coat both the upper and the lower leaf surfaces with spray. A 4–4–50 bordeaux mixture should be used, with 3 to 4 pounds of resin-fish-oil soap added to each 50 gallons. Dissolve 4 pounds of copper sulphate in 25 gallons of water; and slake 4 pounds of stone lime (or 6 pounds of hydrated lime) in a small quantity of water and dilute to 25 gallons. Pour the two solutions together while stirring, and add the soap, which has been previously dissolved by adding a small quantity of hot water at a time and stirring well until the sticky mixture is dissolved. The soap causes the spray to spread and to stick better to the surface of the leaves. Recent work has shown that some of the so-called insoluble copper compounds cause less injury than bordeaux mixture, but in some cases they do not appear to be quite equal to it in fungicidal value. They should be used as directed by the manufacturer.

FIGURE 17.—Tomato fruit worm, showing its characteristic work. (Quaintance and Brues)

EARLY BLIGHT

Early blight is caused by a fungus that produces a blighting of the leaves and a spotting of the fruit and is also responsible for the stem

canker, known as collar rot, which often attacks seedlings near the ground line. The fungus causing this disease is the same as that which causes early blight of the potato, and on the tomato produces dark-colored, circular leaf spots, which are larger and less numerous than those of leaf blight and show concentric rings on their surface. On the fruit this fungus causes large, dark spots, which occur about the stem and may extend deeply into the fruit. Another form of the disease, known as nailhead spot, is especially prevalent in the South. This form causes small reddish-brown spots on the surface of the fruit; these may occur at any point and are only skin deep. The fungi causing these two diseases may live over on the seed or in the soil, and seed treatment and seed-bed disinfection are important in their control. Seed may be effectively treated with Ceresan, as described for the control of damping-off (p. 26), or may be disinfected by being soaked for 10 minutes in a 1 to 3,000 solution of mercury bichloride and then washed for 10 minutes in running water. The seed is then dried and is ready for planting. A 1 to 3,000 solution of mercury bichloride may be prepared by using the tablets ordinarily sold by druggists and dissolving them in three times as much water as is directed for use in making the usual 1 to 1,000 solution. *Care must be taken in the use of this chemical, since it is a deadly poison.* It should be prepared in wooden, glass, or earthenware containers since it will attack metals. Mercury bichloride is not particularly effective in the control of damping-off, and seed so treated should be dusted with red copper oxide before being planted if there is danger of injury from damping-off. In the field, early blight may be checked to some extent by crop rotation and spraying with bordeaux mixture as directed for leaf spot.

LATE BLIGHT

Late blight, which also causes a blighting of the leaves, accompanied by rotting of the fruit, is due to the same fungus that causes potato late blight. Spraying with bordeaux mixture is also a preventive of this disease.

BACTERIAL DISEASES

Bacterial canker and bacterial spot are diseases which often cause serious injury to tomatoes. In plants affected with bacterial canker the disease works upward from the lower leaves. Stems and petioles remain turgid, while the leaflets wilt or turn brown and die. Frequently only one side of the plant is attacked in this manner and the resulting one-sided appearance is characteristic of the disease. Yellowish-white streaks appear on the younger parts of the stem and often crack open, forming the cankers that give the disease its name. Portions of the pith become diseased and yellow, and later form cavities in the stem. On the fruits the disease sometimes causes small, snowy white, round spots which later become raised, with a tan-colored center surrounded by a white halo.

Bacterial spot is most serious in its effect on the fruit, where it forms small, greenish-white, raised pimples that develop a flattened or sunken brown center. Later the pale-green margin disappears; the center becomes brown with a darker margin, and the epidermis is torn and curled back.[4] On the leaves the disease causes small black

[4] BRYAN, MARY K. Three bacterial spots of tomato fruit. U. S. Dept. Agr. Circ. 282, 2 pp., 3 pl. 1933.

and somewhat greasy appearing spots, which may often cause severe injury on seedlings but are less noticeable on older plants.

Both diseases are seed-borne and may often be effectively controlled by treating the seed with corrosive sublimate. Recent work indicates that seed may be freed from the canker organism at the time of harvest by fermenting the seed and fruit pulp for 3 to 6 days at temperatures not exceeding 86° F. or by soaking the seed in an 0.8 per cent solution of acetic acid at the same temperature. Dried seed may be disinfected by soaking in a 0.6 per cent acetic acid solution at the above temperature. The crop should be rotated to avoid soil infection, and where the disease has occurred, the seed-bed soil should be sterilized or treated with formaldehyde dust.

MOSAIC DISEASE

Mosaic causes a green and yellow mottling of the foliage and a general stunting of the plant. Mosaic leaves are somewhat curled and crinkled and may also be distorted in shape. The disease is transmitted from plant to plant by aphids; also by pruning, tying, and other handling of mosaic plants. Mosaic occurs on certain perennial weeds and is carried to the tomato by insects that have previously fed on infected weed hosts. When mosaic once appears in the field it is difficult to control, and every care should be taken to prevent infection of the young plants. Weeds should be kept down in and at the edges of the field and particularly in the vicinity of seed-beds. Plants should never be started in greenhouses where there are older tomato plants affected with mosaic, as the disease is almost sure to be transmitted to some of the younger plants and to pass unnoticed until after they have been set in the field. The virus causing tomato mosaic also affects tobacco and may be present in manufactured tobacco, particularly that used for smoking. It has been shown that plant infection may occur from workers who smoke tobacco, and its use should be avoided when working with young plants.

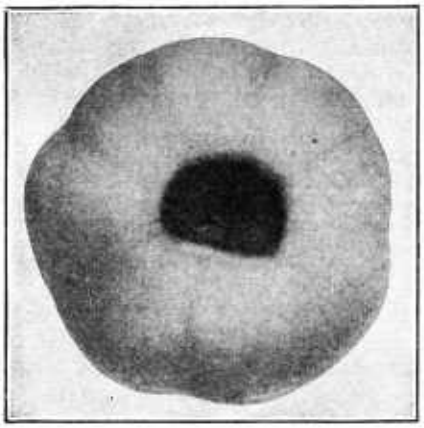

FIGURE 18.—Tomato blossom-end rot

BLOSSOM-END ROT

Blossom-end rot is a nonparasitic disease (fig. 18) which causes a decay of the blossom end of the fruit. The disease usually makes its appearance during or after periods of drought when there is a heavy demand for water on the part of the plant, due to the rapid development of fruit. Loss from the disease can be materially reduced, but not entirely prevented, by avoiding the use of heavy applications of nitrogen, especially manure, and by supplying additional superphosphate. The disease is likely to develop on plants that have grown for a long period under favorable temperature and soil-moisture conditions and are later exposed to high temperature and drought. The application of water to the roots of the plants will frequently check the disease.

WILT DISEASES

The wilt diseases of the tomato are especially prevalent in the South, where two forms of the disease, fusarium wilt and bacterial wilt, are found. The most destructive form, known as fusarium wilt, is caused by a fungus which when once introduced will live almost indefinitely in the soil. Plants affected with fusarium wilt develop a gradual yellowing and wilting of the foliage, which begins with the older leaves and usually causes the death of susceptible plants. One of the chief characteristics of the disease is a brown discoloration of the woody tissues of the stem just below the bark. Where possible the seed-beds should be located on clean soil, and the tomatoes should be grown on land known to be free from the fungus. When such land is not available, however, the disease may ordinarily be controlled by the use of wilt-resistant varieties of tomatoes. The United States Department of Agriculture has developed a number of wilt-resistant varieties, the most widely used of which are the Marglobe, Pritchard, and Glovel. The Marglobe is widely used, both as a market and canning tomato. The Pritchard is a somewhat earlier market tomato of excellent quality and is sometimes used for early canning. Break O'Day is an early trucking variety that gives best results when grown under cool conditions. A wilt-resistant, pink-fruited, shipping variety named Glovel [5] also has recently been introduced by the Department and the Florida Agricultural Experiment Station. All of these varieties are likewise resistant to nailhead rust.

Bacterial wilt causes a rapid wilting of the plant accompanied by a softened and water-soaked condition of the stem. The bacterium causing the disease also affects potatoes, peppers, and other solanaceous crops and will live for some time in the soil. Control measures consist of rotation and the avoidance of a succession of crops that are closely related to the tomato.

A disease known as verticillium wilt, which occurs more commonly in the Northern and Western States, causes a gradual wilting of the plant and a discoloration of the woody portion of the stem that may be confused with fusarium wilt. Rotation is the best means of control, as the causal fungus lives over in the soil and varieties resistant to fusarium wilt are not necessarily resistant to this disease. Two varieties, Riverside and Essar, recently introduced by this Department and the California Agricultural Experiment Station, have shown some resistance to both fusarium and verticillium wilt but are more particularly adapted to canning use under California conditions.

GATHERING AND PREPARING THE CROP FOR MARKET

Early tomatoes grown in the Southern States and those imported into the United States during the winter months are gathered before they are fully ripened, on account of the shipping distance and the time required for them to reach the markets. Two stages of maturity are recognized, depending upon the length of haul and method of shipment: "Green" stock, the individual tomatoes of which are

[5] See U. S. Dept. Agr. Cir. 388, The Glovel Tomato.

gathered before they show any pink color, wrapped in thin paper, and shipped in ventilator cars; "pink" stock, which shows varying degrees of color, is seldom wrapped, and is shipped under refrigeration where the time required to reach the market is more than 24 hours. The tendency in the Southern States during recent years is more and more toward the production of green stock for distant marketing. The green wrapped tomatoes usually carry better, and refrigeration costs in most cases are saved. Where the haul exceeds eight or ten days the green wrapped stock is shipped in refrigerator cars without ice but under ventilation during transit for the first five or six days, and then iced to destination.

Tomatoes that are picked and shipped in the green state do not have the same flavor and quality as those that either become pink or completely ripened upon the vine. For this reason, it is essential in gathering the green stock that they reach as complete a stage of maturity as possible. In the past the pickers of green tomatoes, especially those in the southern Florida districts, have not given proper attention to the maturity of the fruits, the size being the main determining factor, and as a result these tomatoes have gone through a ripening process either before shipment or after reaching their destination. The future of the green-tomato industry depends to a considerable degree upon remedying the present careless methods of gathering the fruit.

No definite rules have been established for determining the maturity of the fruits gathered for green shipment. The most common and practical test is to cut a few average tomatoes crosswise of the seed cells with a sharp knife, and if the pulp that surrounds the seeds has become slightly jellylike, so that the seeds give way before the edge of the knife and are not cut in slicing, they are ready for shipment as green stock. The persons doing the picking soon learn to recognize the proper stage of maturity by color and general appearance. The size of the tomato fruits is no guide to the maturity, as it is the age of the tomato that determines its development. Color and general appearance vary to some extent with different varieties; here again the experience of the pickers must be relied upon. Toward the end of the picking season green tomatoes have a greater tendency toward internal coloring than they have earlier, and for this reason they should be handled more promptly. This is undoubtedly due to extremely hot weather and the exhausted condition of the vines. The tomatoes also as a rule will run smaller toward the end of the picking season.

When it comes to gathering pink stock, color is the main determining factor of maturity. Uniformity of color is extremely important, and it is often difficult to obtain a pack of pink stock that will run uniform. During the height of the shipping season picking should be frequent, every second day or every day, in order to have the fruits uniform and to avoid overripeness. Green stock can be picked twice the first week and three or four times a week thereafter. In many sections the picking is practically a continuous process, the vines being gone over as often as possible and no fruits allowed to become too far advanced.

It should be understood that pink stock shipped 700 or 800 miles under refrigeration as a rule will be ripe enough for use by the time it reaches the consumer, but that the green stock either ripens in

transit without icing or is placed in a ripening room when it reaches its destination. In any case it is essential that the green stock be repacked, the riper fruits being placed in packages by themselves and the greener ones held until properly colored. Many of the wholesale dealers in tomatoes maintain repacking and ripening rooms during the shipping season. As the cars are received the tomatoes are sorted, and those requiring further ripening are placed in a room at a temperature ranging from 70° to 75° F., with suitable moisture conditions and held three to six days or sometimes longer, until they are ripe enough to be placed on sale. The usual method of maintaining proper moisture conditions in the ripening rooms is to place a few shallow pans of water on the floor in different parts of the room and by the use of small sprinkling cans to spray a little water over the paper wrappers of the green tomatoes that have been repacked. By maintaining proper moisture conditions there is very little loss from shrinkage in the weight of the tomatoes, and the fruits do not have a shriveled appearance when they become fully ripe.

Formerly, early green tomatoes were practically all packed on the farms where grown, but this system has now been largely replaced by packing in centralized sheds. Where the tomatoes are packed on the farm a temporary shelter or shed is usually constructed at one end or side of the tomato field. Sometimes a wagon shed or similar shelter near the dwelling is used. By the centralized packing method the grower is relieved of everything pertaining to packages and packing and simply delivers his product to the packing shed and receives a duplicate slip covering the weight or number of packages delivered, while the entire work of grading and packing is done by the packing shed force.

FIGURE 19.—Green tomatoes wrapped in special paper and packed in 6-basket carriers

Galvanized-iron buckets, half-bushel round-bottom stave baskets similar to those used for picking orchard fruits, 12-quart climax baskets, and 16- and 20-quart round hamper baskets are used for picking in the field. Of these, the half-bushel round-bottom orchard baskets with broad collapsible wood handles are perhaps the most desirable. Where the tomatoes are transferred in the field from the picking utensils to lug boxes, bushel crates, or bushel baskets for hauling to the packing shed, great care must be taken in pouring them from one container to another, to avoid bruising. The interior of all picking utensils should be carefully inspected to see that there are no sharp edges, nail points, or rough surfaces to injure the fruit. Many growers follow the practice of lining their picking baskets with heavy muslin, light canvas, or burlap. Small breaks in the skin which may not be noticed when the

tomatoes are packed often cause serious loss in transit and on the market. Field crates or lug boxes used for hauling the tomatoes from the field to the packing shed should be light in weight, but strong and durable. They should be provided with cleats across the top at each end to prevent bruising the fruit either in the wagon or in stacking at the packing shed. The lug box used for hauling oranges from the grove to the packing shed in Florida is a desirable type, but it has the objection that it is too large for one man to handle. A good type of bushel box is, from many standpoints, better. Tomatoes should never be hauled in bulk, even though the wagon bed is well padded, as the weight of the fruit in a load 20 to 26 inches deep causes serious bruising and internal injury of the fruit.

Pink stock in the past has been packed more largely on the farms where grown than green stock, but recent developments have been along the line of centralized packing and handling. The methods used are practically the same as those for green stock, except that the pink stock is not wrapped in paper and must be handled with the least possible delay.

Early tomatoes grown in the Southern States are packed largely in 6-basket carriers and 4-basket flat crates of the type shown in Figures 19 and 20. The grades, packs, and type of package used for handling southern early tomatoes, which are shipped mainly to the northern markets, are fully described in Farmers' Bulletin 1291, entitled "Preparation of Fresh Tomatoes for Market," and the consideration of these subjects is therefore omitted from this publication. The methods of handling tomatoes grown for local sale in the Southern States as well as those of the producing sections in the Northern and Eastern States are, however, so different from those of the shipping sections of the South as to require description in this bulletin.

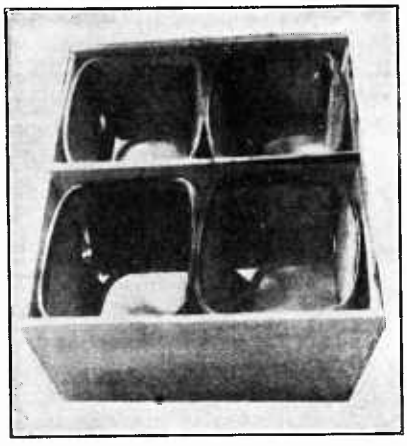

FIGURE 20.—A 4-basket carrier used in some sections for shipping early tomatoes

The degree of ripeness of tomatoes grown for the early and general markets in the regions outside of the intensive early sections of the South depends upon the locality and the method of delivery to the markets. Those grown in Tennessee, southern Ohio, and other sections of similar latitude and conditions are gathered in the advanced pink stage or when this color covers two-thirds or three-fourths of the tomato. In this condition the tomatoes will be ready for use by the second or third day after gathering and in many cases will keep from 5 to 7 days in good condition. In sections where the tomatoes are hauled direct to the market and offered for sale within 24 hours of the time they are gathered, the fruits are allowed to become almost fully ripe upon the vines. Tomatoes that are grown for household canning as a rule are left on the vines to become uniformly red ripe, but not soft or overripe. During the early part of the season while prices are high the plants

are gone over every day or every second day, but during the height of the season the tomatoes are usually gathered about twice or three times a week.

The methods of packing tomatoes for local markets vary in different localities. Most of those grown for the early market, however, are gathered in field baskets and either hauled or carried to a central packing shed, where they are cleaned by means of soft cloths and then packed in baskets, crates, or whatever package is best suited to the market. Peck and half-bushel splint baskets with handles and 12-quart climax baskets are often used, especially during the earlier part of the season. In some sections the half-bushel round hamper is a favorite package. The New Jersey 20-quart crate is widely used in the Swedesboro and southern New Jersey sections for car-lot shipments of fresh tomatoes. A larger size, holding 1 bushel, is popular in northern New Jersey, adjacent to New York. These crates are usually made from unfinished material, presenting a rather unattractive appearance in the markets. They have the disadvantage that the weight of the fruit in the package frequently causes crushing of the bottom layers. They have the advantage, however, of being strongly made and seem to give satisfaction in the movement of low-priced stock to neighboring markets. The 20-quart brace hamper or round basket used in the Philadelphia and Baltimore districts for rail and boat shipments to canneries is very extensively used for marketing tomatoes. In most cases these baskets are nested together and returned to the growers. In the shipping sections of Ohio, Indiana, Illinois, and Missouri the 12-quart climax basket is used to some extent, but has the disadvantage that the handles are easily broken and that it is rather deep, and a single overripe fruit in the basket is liable to injure its entire contents. In the New England States the standard bushel or "Boston box" is most generally used. The inside dimensions of this box are 17½ by 17½ by 7$\frac{1}{16}$ inches. When carefully packed with firm, smooth, uniform-sized tomatoes, this box holds 60 to 63 pounds.

The important consideration in the selection of a package for the local marketing of tomatoes is to secure one that is strong, of neat appearance, and that can be conveniently handled. Where the tomatoes are sold in the original package to families, the 4-quart flat basket, the 1-peck splint basket, the 12-quart climax basket, and the half-bushel round hamper are desirable packages. Tomatoes that are to be used for canning in the home are most conveniently delivered in half-bushel round baskets or in standard bushel boxes or crates.

One important factor in the handling of tomatoes is that the containers and the wagon, truck, or other vehicle on which they are transported shall be adapted to each other. In many cases special racks or frames are built upon the wagons to carry the baskets or hampers. Standard bushel boxes are almost universally constructed with raised ends or covers so that they will pile one upon the other.

In the southern New Jersey early tomato section the leading markets of the eastern United States are within truck-hauling distance, and a large part of the crop is delivered by motor truck. While the district around Swedesboro still holds a record for very heavy car-lot shipments, the building of hard-surfaced roads to Philadelphia and other eastern cities has made possible the hauling of 80 to 100 bushels

at a truck load, and large quantities are moved in that manner. Tomato-growing sections that are located on the rivers and salt-water inlets ship by boat to a considerable extent. Water transportation, however, as a rule, is too slow for the handling of early or truck-crop tomatoes, and boats are used primarily for the transportation of those intended for canneries.

Adherence to the standard grades, as described in Farmers' Bulletin 1291, is of great importance from the standpoint of increasing the demand for table tomatoes. The southern grower can gain nothing by sending hundreds of miles to market culls that must be either discarded when re-sorted or sold at a price that will not pay transportation and handling costs. The term "culls" as used here includes all undersized and immature fruits, as well as those that are rough, cat-faced, and irregular; also those that are cracked and leaky and in such condition that decay sets in during transit. The centralized packing shed with expert graders and packers has gone a long way toward educating the growers (1) in the production of a high-grade product and (2) in the matter of proper gathering to leave the culls in the field and to bring only marketable stock to the packing shed. Cases are known where individual growers have had less than 10 pounds of "rejects" from a whole day's picking of 3 to 5 acres of staked and pruned tomatoes.

In the northern sections, where the fruits are packed largely in the field or in packing houses located on the farms, it is extremely difficult to establish grades, and the result of this lack of uniformity and standards is reflected in the prices obtained. Cases have come under observation where high-grade tomatoes of superior quality, well packed in standard bushel boxes, were selling for $4.50 a box on the grower's premises, while miscellaneous, field-run tomatoes of another section which were dirty, lacking in uniformity of ripeness, and poorly graded were a drug on the same market at $1.50 per bushel. The grower of the high-grade tomatoes was making a handsome profit, while those who were producing the low-grade stock were complaining that there was nothing in the growing of tomatoes.

SUMMARY

Profitable early tomato production depends to a considerable degree upon the selection of soil of the proper character in a well-protected location, with good drainage and abundant drought-resisting properties.

Good seed of a variety and strain adapted to the purpose for which the crop is being grown is very important, and while seed of this character should cost very little more than ordinary seed the matter of price paid for the seed should be of secondary consideration.

The proper growing of the plants by means of hotbeds, coldframes, blocking off, and in some cases by the use of pots is essential to the production of a satisfactory early crop of tomatoes.

The intelligent use of manure and fertilizer and the thorough preparation of the soil are essential steps in profitable tomato growing. Frequent shallow cultivation and the spraying of the plants to protect them from insect and disease injury is essential.

Tomato plants should not be set in the open ground until all danger of frost is past, and earliness as well as yield depends to a considerable degree upon the care used in transferring the plants from the plant bed to the field.

Staking and pruning the plants is a distinct aid in the production of an early crop, but may not be practicable on a large scale. The proper maturity of the fruit, depending upon the distance from market and the method of handling, is highly important, and a knowledge as to when the fruit should be gathered must be gained largely by experience. It is the age rather than the size of the fruit that determines its stage of maturity.

The production of high-grade uniform fruit is essential, but the proper grading, packing, and marketing of the crop largely determine the profits.

Early and truck-crop tomatoes are now grown on a very large scale, approximately 32,000 cars of early and intermediate crops being shipped annually.

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